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On the Development of Saururus cernuus L.

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(WITH PLATE 23)

The naked flower and the form of the carpel of *Saururus* have always led botanists to place it among the simpler Dicotyledoneae, usually in the Piperaceae. Engler has recently aroused new interest in all of these forms by separating from the Piperaceae the genera *Saururus*, *Anemiopsis*, and *Houttuynia* and constituting of them the family Saururaceae, which he regards as the simplest of the Dicotyledoneae after *Casuarina*. It was the desire to discover whether the evidence obtained from a study of the details of development would bear out this view of Engler that led me to undertake work on the Piperaceae collected by Professor Humphrey in Jamaica in 1897, and on material of *Saururus cernuus*, collected in Baltimore and North Carolina in 1899. The work on the Piperaceae will appear elsewhere and I give here a preliminary account of some features of the development of *Saururus*.

The one to three spikes of flowers are terminal in origin, but are soon pushed aside by the more vigorous growth of the last lateral bud. The flower consists of six stamens, and usually four carpels somewhat fused at the base, borne on the upper surface of a spoon-shaped bract. According to De Candolle the whole flower may sometimes be stalked from the axil of the bract.

The stamens arise on the upper and outer surface of the bract when the latter is but a slight swelling from the side of the axis. Soon after this the carpels appear as horseshoe-shaped elevations in the area within the circle of stamens, the lower flowers of the spike being always much further developed than the upper ones.

The stamen has four pollen-sacs, each with a many-celled archesporium, the wall and tapetum being formed in the usual way. The pollen grains are shed soon after the definitive macrospore of the same flower is formed. They are then binucleate and have a large thick area in the wall on one side. Nothing has been seen as yet of the sprouting of the pollen grain or the mature pollen tube. Further careful work will probably discover this, though it is certain that the pollen tube is much less prominent in the tissue of the style than in the related genus *Peperomia*.

Soon after the edges of the carpel meet and before they have fused far above the base, a single ovule appears on the inner face of each half of the carpel near the suture (*ov*, Fig. 2). These ovules are clearly lateral in origin and not, in any case seen, basal as described by De Candolle. Neither was any case found of a third or fourth ovule as described by Bentham and Hooker, though the latter character may perhaps be variable like the insertion of the flower noted above.

The ovules are sessile, orthotropous and at first transverse. They originate at about the same level, but very soon one pushes above the other with the micropylar end upward, and elongates parallel to the axis of the carpel until finally it fills practically the whole cavity of the latter. The lower ovule may develop far enough to form a ripe embryo-sac, but no case of fertilization of this was seen, and in the later stages it is transverse and flattened against the bottom of the cavity of the carpel by the erect upper ovule (*nc*, Fig. 4). The latter develops to form the single seed of the ripe fruit (Fig. 6).

The archesporial cell is single and axial, though at first there are often two or three cells equally near the axial position in the nucellus. The primary archesporial cell divides to form a tapetal cell and a definitive archesporium. The former gives rise to but few cells (*tp*, Fig. 5), which do not thicken their walls as do the tapetal cells of *Peperomia*.

The definitive archesporial cell or macrospore mother cell divides by mitosis into an upper and a lower cell, of which the upper divides once more while the lower immediately develops into the functional macrospore or embryo-sac mother cell, which pushes downward into the nucellus and upward to destroy the two degenerating macrospores above (*es*, *des*, Fig. 3).

At about the time that the primary archesporial cell becomes distinguishable the development of the inner integument begins. This is soon followed by the outer integument, arising in the same way from the surface cells at the base of the nucellus; both integuments closing in to form the micropyle at about the time the macrospore begins to encroach on its sister cells. The first division of the macrospore is transverse, and the following divisions apparently occur in the normal manner, as we find a little later an eight-nucleate and then a typical seven-nucleate embryo-sac (Fig. 1). The oösphere is rather clear or with large vacuoles, while the synergids which also have definite walls, have much denser contents (*eg*, Fig. 1). The polar nuclei fuse near the middle of the embryo-sac to form a nucleus twice the size of the egg nucleus (*epn*, Fig. 1). The antipodals are apparently quite normal at first, each with a darkly staining nucleus, but they soon become flattened against the base of the embryo-sac. Then their nuclei disorganize and the antipodals are no longer distinguishable, probably playing no further part (*ant*, Fig. 1).

After the seven-celled embryo-sac is formed it grows rapidly, especially in length, breaking down the tissue of the enlarging nucellus till it reaches two-thirds of the way to the base of the latter (Fig. 4), a length of 250 micromillimeters. Finally it broadens at the base, remaining narrow at the top, assuming thus the shape of a long-necked flask, with the egg apparatus at the top and the endosperm nucleus at the base of the neck.

It is evidently at about this time that fertilization occurs, for soon after this the endosperm nucleus divides. One of the daughter nuclei remains in the neck while the other moves down into the body of the flask, and then a wall is immediately formed across the base of the neck giving rise thus to two endosperm cells (*epn*, Fig. 4). From this time on the upper nucleus divides frequently, a cell wall forming immediately each time, and the neck of the embryo-sac thus becomes filled with a number of endosperm cells before any change is perceived in the egg or synergids (*ep*, Fig. 5). The lower of the first two endosperm nuclei grows to a very large size (*epn*, Fig. 5), but never divides further. It lies in a thin layer of cytoplasm near the wall of this large, lower endosperm cell and seems to control the advance of the latter upon

the tissue of the nucellus. The nucleus persists for a long time but finally begins to show signs of degeneration and when the seed is ripe there is no distinct nucleus to be seen. Darker granules, which may be remnants of the nucleus, are sometimes seen in the otherwise faintly staining contents of this lower endosperm cell, or haustorium as it may perhaps prove to be in function (Fig. 6).

The egg begins to develop when the neck contains a dozen or more endosperm cells. The first division and several of the succeeding ones seem to be transverse. A suspensor a few cells in length is thus formed (Fig. 6), and at the lower end the embryo is developed. The latter in the ripe seed shows a pointed micropylar or root end and two slightly projecting cotyledons below with no distinct stem apex between them (Fig. 6). An axial strand of procambium is just evident at this stage.

The endosperm of the neck has by this time expanded laterally, and uses up practically all of the nucellus above and at its sides. It thus forms a double cone of tissue occupying the apex of the seed, with its lower point pushing in the upper wall of the lower endosperm cell (Fig. 6). The cells of this cap of endosperm are thin-walled, have small nuclei and are filled with a granular darkly staining substance, evidently cytoplasm. Several layers of the endosperm cells nearest the embryo are devoid of stainable contents, though their walls are still distinct, and none but those immediately in contact with the embryo have their walls compressed together. These empty cells are shown unshaded in Fig. 6.

The fate of the synergids of the embryo-sac has not thus far been determined.

The stored food material is evidently contained chiefly in the very abundant nucellar tissue or perisperm (*psp*, Fig. 6), which is closely packed with starch. This tissue is developed by the rapid growth of the basal part of the nucellus (Figs. 1, 4, 6), which finally fills nine tenths or more of the ripe seed, the cells being arranged in rows radiating out from the lower endosperm cell (Fig. 6).

The carpel at this time forms a thick, warty coat of several or many layers of outwardly rather loosely packed cells, the whole evidently serving, by means of the enclosed air, to float the fruit in

the water, into which they often fall, and by which they must frequently be transported (*cp*, Fig. 6).

The inner integument is of three layers of which the inner and outer are of transversely elongated cells, the walls of which become thickened to the occlusion of the cell cavity. The cells of the middle layer remain thin-walled and are crushed between the other two (*iin*, Fig. 6—the whole thickness of this integument indicated in solid black). The outer integument is of two layers, the outer usually of larger cells, both with thin walls (*oin*, Fig. 6). These two layers appear as a whitish filmy coat over the dark inner integument when the carpel is removed from the ripe seed. At the base of the ovule a mass of chalazal cells becomes greatly thickened in the ripe seed to complete the testa in this region (Fig. 6).

THE GERMINATION OF THE SEED

The exact time and rate of sprouting under natural conditions has not been observed as yet, since the plants under observation near Baltimore failed to develop good seeds last season. Fruits obtained on the grounds of the New York Botanical Garden were kept in moist *Sphagnum* at a low temperature, from January to May, without showing any inclination to germinate. This may possibly have been due to the absence of light, though other experiments indicate that other factors were concerned. Some of the fruits were placed in damp *Sphagnum*, others in water, and still others in soil. All were given plenty of light and kept at a temperature of twenty five degrees centigrade, but none of these gave any external indication of sprouting, and sections showed that no appreciable change in the form or relation of embryo, endosperm and perisperm occurred during two months' time.

About the first of April, however, all the seeds that had been kept warm and given light and air, began to sprout freely. Then it was found that at this time the seeds that had been cool and dark also sprouted readily when given light and heat. These observations seem to show that changes occur here, not morphological, but probably of a chemical nature, such as are known to occur in many other seeds, and that these changes can take place under quite different conditions of light and temperature.

A careful study of the processes of germination shows that the

first noticeable change in the seed is a swelling of the endosperm, which finally burst through the seed coats at the top and projects through the rent in these and the carpel as a white papilla (*ep*, Figs. 7, 9). This swelling enlarges the cavity occupied by the embryo in the endosperm and soon the embryo shows signs of renewed development. The root end elongates and the cotyledons grow downward and bend together at the ends (*em*, Fig. 7). Still later the root of the embryo pushes through the tip of the endosperm papilla till finally everything but the cotyledons is free. The latter remain tightly grasped by the collar-like end of the endosperm papilla, and reach at first not nearly to the bottom of the cavity in the latter (*cot*, Fig. 8).

During this time the only change in the relation of the endosperm and perisperm is that the former pushes down slightly into the large lower endosperm cell or sac (*ep*, Figs. 7, 8). As development goes on the hypocotyl elongates, pushing the root down into the soil, and the cotyledons stretch to push the stem growing point well out of the seed in one direction (*cot*, Fig. 9), while their tips push inward and thicken to force the endosperm which covers their tips like a cap, down against the tissue of the perisperm (*cot*, *ep*, *psp*, Fig. 10). The latter is gradually broken down by the encroaching endosperm, till in the later stages of germination it forms a second cap over the cotyledons outside the endosperm (*psp*, Fig. 10). After the root penetrates the substratum the hypocotyl continues to elongate and thus the whole fruit is raised into the air supported by the cotyledons (Fig. 9). The latter become broadly ovate, with only the narrow thick tip enclosed by the endosperm, and separate at the base to allow the plumule, which is now formed, to push its way out.

In the latest stages just before the fruit drops from the cotyledons the endosperm consists of a thin layer of compressed cells, without noticeable nuclei or other contents. Though the tip of the endosperm which projects out of the seed is exposed to the light, there was no indication that functional chloroplasts are ever formed.

The perisperm is either similarly flattened against the integument, or, in other cases, the cells seem to be emptied of their starchy contents while the walls retain their former shape. Whether the endosperm plays any part in the secretion of an enzyme for the

digestion of the perisperm is as yet uncertain, but soon after the embryo pushes out of the seed the endosperm cells begin to lose their contents and do not appear like actively secreting cells.

The epidermal cells of the tips of the cotyledons have very dense contents and retain this character as long as they remain in the seed. On the surface of the cotyledons, at the tip, while they are still imbedded in the endosperm far from the light, and before chloroplasts are visible in the cells of this region, structures like typical stomata are formed abundantly. These stomata or stoma-like structures seem more abundant and more widely open at the very tip than elsewhere on the cotyledons. This fact suggests their possible connection with the absorption of food material. This has, however, not yet been proven.

Of the older seedling, after the empty carpel drops off, I need say here only that the first leaf from the plumule expands during the fourth or fifth week, and the second soon follows. In seedlings of seven or eight weeks the cotyledons cease growth, at a length of about four millimeters; the two stem leaves at this time assume nearly the typical cordate form of the mature leaf.

CONCLUSION

I have elsewhere stated that I failed to find in the development of the embryo-sac of *Peperomia* any essential primitive features, and the present study of the related genus *Saururus* has failed in a similar manner, it seems to me, to indicate this plant as especially primitive. The origin of the parts of the flower and the development and structure of the mature embryo-sac are essentially as found generally in the Angiosperms. The immediate formation of cell walls in the endosperm occurs, as Hofmeister has shown, in more than twenty different families of this group. The occurrence of further cell walls in but one of the first two endosperm cells he has also shown to be a not infrequent phenomenon. Thus *Asarum*, *Nymphaea*, *Plantago*, the Campanulaceae, Labiatae, etc., resemble *Saururus* in forming cellular endosperm in only the upper of the first two endosperm cells; while in *Catalpa*, *Acanthus*, and other forms, it is formed in the lower cell of the pair.

Again the slightly developed embryo and the small amount of endosperm in the ripe seed, are found not only in the Piperaceae, but in such distantly related forms as *Nuphar*, *Brasenia* and other

Nymphaeaceae, as well as in many parasitic genera, of various families, and much of the nucellar tissue remains also as perisperm in certain of the Chenopodiaceae, Caryophyllaceae, and in the Cannaceae among the Monocotyledoneae. All of these facts seem to me to show that *Saururus* is not among the higher Dicotyledoneae, but for the support of the view that it is among the very lowest, we must rely entirely upon a single character, namely, the absence of the floral envelopes.

Finally the behavior of the endosperm at germination is unique so far as I have been able to learn from the literature. We may best regard it perhaps as the lower member of a series of which such seeds as those of *Phaseolus* and *Cucurbita* form the other extreme. In other words, in seeds of the latter type, the endosperm completes its function of absorbing the tissue of the nucellus, and passing this on to the embryo, during the ripening of the seed, while in *Saururus* the final result is the same, but is only reached during the germination of the seed.

Explanation of Plate 23

Abbreviations used. *ant*, antipodal; *cot*, cotyledon; *cp*, carpel; *des*, degenerating embryo-sac mother cell; *ea*, egg apparatus; *eg*, oösphere; *em*, embryo; *ep*, endosperm; *epn*, endosperm nucleus; *es*, embryo-sac mother cell; *in*, integument; *iin*, inner integument; *nc*, nucellus; *oin*, outer integument; *ov*, ovule; *psp*, perisperm; *sg*, synergid; *st*, stigma; *tp*, tapetal cell; *vb*, vascular bundle.

1. Longitudinal section of ovule with mature embryo-sac, × 250.

2. Transverse section of carpel near the base, showing two ovules. The dotted lines indicate the line of fusion of the edges of the carpel figured and of this with the adjacent carpels, × 50.

3. Tip of nucellus with tapetal cells, one functional and two degenerating embryo-sac mother cells, × 775.

4. Longitudinal section of carpel showing two ovules, one with flask-shaped embryo-sac, × 50.

5. Longitudinal section of embryo-sac slightly older than the last, × 150.

6. Longitudinal section of ripe fruit, showing degree of development of embryo, endosperm, perisperm, integuments and carpel, × 40.

7. Longitudinal section of sprouting seed, showing pushing out of endosperm and renewed development of embryo, × 30.

8. Part of longitudinal section of sprouting seed, showing embryo attached by cotyledons to endosperm, × 30.

9. A twenty-day old seedling, showing relation of cotyledons, endosperm, seed coats and carpel, × 7.

10. Longitudinal section of the seed and cotyledons of such a seedling showing the encroachment of the endosperm upon the perisperm, × 14.

Studies in Sisyrinchium—VIII: Sisyrinchium Californicum and Related Species of the Neglected Genus Hydastylus

By Eugene P. Bicknell

The well-known *Sisyrinchium Californicum* of Aiton's Hortus Kewensis has rested for so long undisturbed in the genus *Sisyrinchium* that some fault of iconoclasm would seem to attend its removal from its time-honored place. Nevertheless the generic misfit of the plant in *Sisyrinchium* was long ago apprehended and a separate genus was created for it by Salisbury on the suggestion of Dryander (Trans. Hort. Soc. 1: 310. 1812). This genus, *Hydastylus*, adequately founded as I do not doubt, appears to have missed the sanction of any later systematist.

The species was first brought to notice by Archibald Menzies who imported it into England for cultivation in 1796. Ten years later it was described and figured by Ker-Gawl as *Marica Californica* (Bot. Mag. *t. 983*, 180?), a disposition of the plant manifestly having regard for family relationship rather than generic affinity.

In 1812 Aiton, or Dryander, it may be, with clearer view transferred it to *Sisyrinchium*. The same year Dryander and Salisbury reached a truer conception of the plant's separateness of structure from *Sisyrinchium*, and their genus *Hydastylus* must now be revived to accommodate not this plant alone but also a well-defined generic group of yellow-flowered species of which it is the type.

The genus *Hydastylus* may be thus characterized:

Annual or perennial herbs with the habit and appearance of *Sisyrinchium*, but usually only imperfectly caespitose, discoloring or turning black in drying, most or all of the species staining purple under appropriate conditions; rootstocks usually obscure or poorly developed, the delicate roots pale and slender. Leaves narrowly linear, the conduplicate bases more or less membranously expanded: stems ancipital, simple and scapose, terminated by a spathe of two conduplicate bracts enclosing membranous scales; pedicels slender, often long-exserted, straight or finally recurved: perianth yellow, the mostly narrowed segments black-lineate or with brown

or orange veins, obtuse or acute but not aristulate nor emarginate; filaments more or less adherent below but commonly free nearly to the base or at least for more than half their length, somewhat spreading above; anthers narrowly linear, versatile; style-branches slender, divergent: capsule oblong to globose or pyriform, more or less trigonous, three-celled, many- or few-seeded: seeds rounded, distinctly pitted, widely umbilicate or acetabuliform.

Western North American from Vancouver to Lower California and at least to southern Mexico, extending east to Arizona and Coahuila.

The most evident points of difference between this genus and *Sisyrinchium* reside in the flowers and consist of partially free filaments, linear versatile anthers and slender spreading style-branches, together with yellow perianth, the lineate segments never aristulate nor emarginate and strictly glabrous ovary. In addition there is some indefinable foliar attribute which with more or less clearness announces the genus quite apart from the flowers. In fact two of the species here described are confidently referred to the genus although the flowers are unknown.

It will doubtless be found to be in accordance with the alignment of nature to limit the genus *Sisyrinchium* by the characters of tubular-united filaments, short erect anthers, undivided style and, with rare exceptions, blue, violet or white flowers, with the perianth segments aristulate or acutely pointed; furthermore the ovary is puberulent in the majority of species.

This understanding of the genus will exclude from it a number of South American species which it has hitherto been held to embrace and make necessary the formation of still other genera, but this, I fully believe, will prove to be the only logical treatment of the group. There might have seemed little reason for this view under the long-established belief that the genus in North America was at best a most insignificant one but now that its numerical importance has disclosed itself the beautiful homogeneity of the species of the blue-flowered section becomes in itself very suggestive and bears strongly against the congeneric equivalent with their group of the heterogeneous assemblage of species that have been included within it.

On this view *Sisyrinchium* proper is primarily a North American genus which though well-represented in South America has there a much less extensive representation than has been accorded it.

Of the genus *Hydastylus* it should be said that it may require to be more broadly interpreted in order to accommodate certain branched and yellow-flowered South American species which have yet to be made a subject of critical study.

Key to the Species of Hydastylus

Flowers large; perianth 12–18 mm. long; leaves 2–7 mm. wide, mostly turning very dark when dry.
- Flowers large; pedicels mostly longer than the bracts, 20–40 mm. long; seeds 1.25–1.5 mm. in diameter. 1. *H. Californicus.*
- Flowers smaller; pedicels mostly shorter than the bracts, 10–20 mm. long; seeds .75–1 mm. in diameter. 3. *H. brachypus.*

Flowers small to medium sized, 6–12 mm. long; leaves mostly 1–3 mm. wide, not usually turning very dark; pedicels not recurved.
- Anthers small, 2–2.5 mm. long.
  - Pedicels little longer than the bracts, erect; perianth 8–10 mm. long. 2. *H. borealis.*
  - Pedicels slenderly exserted, somewhat spreading; perianth 6–8 mm. long. 5. *H. rivularis.*
- Anthers larger, 3–5 mm. long.
  - Pedicels more or less exserted, erect; perianth 8–12 mm. long. 4. *H. Elmeri.*
  - Pedicels long-exserted, closely erect; plant slender, 15–30 cm. high; perianth 8–12 mm. long. 6. *H. longipes.*
  - Pedicels long-exserted, somewhat spreading; plant low or depressed; leaves 1.5–2 mm. wide. 7. *H. parvus.*
  - Pedicels exserted; plant low or depressed; leaves .05–1.5 mm. wide. 8. *H. Schaffneri.*

Flowers very small, 3–5 mm. long; pedicels recurved-spreading; capsules 3–6 mm. long.
- Outer bract much prolonged; anthers 1 mm. long. 9. *H. cernuus.*
- Bracts subequal; anthers 3–5 mm. long. 10. *H. subcernuus.*

Flowers unknown; leaves very thin; capsules 6–10 mm. long.
- Capsules large, 8–10 mm. long, pyriform; leaves and stem 2–5 mm. wide, serrulate; pedicels flexuous. 11. *H. serrulatus.*
- Capsules 6–7 mm. long, obovoid-oblong; leaves and stem narrower, not serrulate; pedicels spreading or recurved. 12. *H. translucens.*

HYDASTYLUS CALIFORNICUS (Ker.) Salisb. Trans. Hort. Soc. 1: 310. 1812.

Marica Californica Ker-Gawl. Bot. Mag. *t. 983.* 1806.

Sisyrinchium Californicum Hort. Kew. ed. 2, IV.: 135. 1812.

Sisyrinchium lineatum Torrey, Pac. R. R. Rep. IV., 143. 1857.

Sisyrinchium flavidum Kellogg, Proc. Cal. Acad. II.: 50. *t. 3.* 1863.

Mostly 20–30 cm. high (15–60 cm.), dull green and glauces-

cent, turning dark or often quite black on the herbarium sheet and readily staining a deep purple, roots spreading from a weak descending rootstock. Leaves thin and rather openly weak-nerved, mostly about half the height of the stem but sometimes equaling it, obtusely pointed, commonly 2–4 mm. wide (1.5–7 mm.): stem usually 2–3 mm. wide, sometimes broadly wing-flattened and becoming 6 mm. wide, the edges like those of the leaves smooth or obscurely serrulate-roughened: spathes erect, 3–8 mm. wide in pressed specimens; outer bract 20–52 cm. long, narrowed to an obtuse point, occasionally subequal with the inner one but usually slightly surpassing it and sometimes as much as 20 mm. longer, the margins below narrowly hyaline, often purplish, united-clasping for 5–10 mm.; inner bract 20–35 mm. long, white-scarious and obtuse or obtusely pointed at the apex; interior scales brownish hyaline, often slightly exserted: flowers 3–7, on erect pedicels 20–40 mm. long, usually a little surpassing the bracts, at least the inner ones, and sometimes exserted as much as 10 mm.; perianth bright yellow, 12–18 mm. long, the oblong obtuse or acutish segments with 5–7 black or dark brown nerves which often become tortuous or crinkled when dry: stamens about 7 mm. high, subequal with or surpassing the style branches, the narrow versatile anthers orange-yellow, 3.5–5 mm. long: capsules on erect pedicels, at maturity 7.5–12 mm. long, 6–8 mm. wide, trigonous-obovoid or ellipsoid, becoming very dark: seeds numerous, 1.25–1.5 mm. in diameter, black, strongly pitted, excavated-umbilicate.

Coast region of California, in marshes, perhaps exclusively within maritime influence, from San Diego to Mendocino County, flowering from April to June.

SAN DIEGO, Pac. R. R. Rept. l. c.

MONTEREY Co., C. C. Parry, M.D., April, 1850, in full flower, type of *S. lineatum* Torrey; Mrs. Rich, on sheet with type; Herb. Columbia.

Near the 35th parallel, Dr. J. M. Bigelow, Whipple's expedition, 1853–4.

CONTRA COSTA Co., Antioch, Dr. A. Kellogg, April 21, 1870, just in flower.

SAN FRANCISCO, Mrs. Brandegee; Kellogg and G. W. Harford, 1868; Kellogg, 1866; Presidio, 1887, Edward L. Greene.

SAN MATEO Co., Crystal Springs, April, 1896, Miss Alice Eastwood.

SONOMA Co., Michener and Bioletti, 1892; Bodega Point, Eastwood.

MENDOCINO Co., Bolander, 1866; Eastwood, 1894; H. E. Brown, 1898.

Specimens from "California" have also been examined, collected by Dr. Gibbons (1853), Dr. Coulter and E. Hall.

IRELAND, near Wexford, Rev. E. S. Marshall, June, 1896, fide A. B. Rendle, Journ. Bot. XXXIV., 494.

Numerous specimens covering the extended range of this plant of at least seven hundred miles along the California coast show a great amount of variation and give indications apparently little less than conclusive of two closely allied species within the region.

The type locality of *H. Californicus* is stated to be "Port Bodega" (A. B. Rendle, l. c.), from whence specimens were taken to England over a century ago. Recent collections by Miss Alice Eastwood, made at Bodega Point, Sonoma County, presumably the type locality, are of the form which has been most frequently collected and which shows certain rather suggestive differences from the type specimens of Torrey's *S. lineatum*. As a rule this more northern plant is taller and less discolored from drying with longer and thinner often broader leaves and longer spathes having the outer bract often considerably prolonged, flowers larger, apparently more delicately veined and with the segments less broadened toward the apex, and longer anthers. Present material is not conclusive as to the exact relationship of these two forms, but it would seem that Torrey's specimens may represent a closely allied species of more southern range extending from San Diego to San Francisco, the true *H. Californicus* perhaps not ranging far south of San Francisco. It may be now impossible to determine from Kellogg's description of his *S. flavidum* to which of these plants his name implies. It may be noted, however, that in the Herbarium of the California Academy of Science are two sheets of the more northern plant labelled in pencil "*S. aureum* Kellogg" and another sheet bearing specimens of both plants with penciled memoranda noting their differences. It would appear that these were part of Kellogg's material and since they bear date some years later than the publication of his *S. flavidum* the inference is that he regarded his *S. aureum* as distinct from the latter which would thus be shown to be identical with Torrey's *S. lineatum*.

A somewhat distinct appearing form of the plant which would seem to belong with true *H. Californicus* if two species are ever to be distinguished is indicated by the specimens collected by Dr. Bigelow on Lieutenant Whipple's expedition of 1853–4. These are remarkable for their low stature as compared with their broad leaves and stems, which are 3–6 mm. wide, and their stout spathes; the broad thin wings are notably broadened towards the top of the stem but abruptly contracted at the spathe as in *H. brachypus*, described beyond, but unlike the latter the flowers are of the largest size, becoming 18 mm. long, on slightly exserted pedicels, and the spathes are much larger with the outer bract more united-clasping and the inner one less obtuse.

Quite an opposite extreme of development is shown by specimens from Sonoma Co. collected by Michener and Bioletti. These are remarkably tall and slender with short spathes and decidedly exserted pedicels.

Hydastylus borealis sp. nov.

Very close to *H. Californicus* but ordinarily much smaller and more slender, with spathes and flowers about one half the size, much smaller stamineal-column and anthers, smaller capsules and decidedly smaller seeds.

Commonly 15 cm. high (6–30 cm.) not usually turning very dark in drying and when young showing little discoloration; roots usually more slender and delicate than in *H. Californicus*, often much elongated. Leaves commonly only 1–3 mm. wide, rarely 4 mm., often with abruptly linear tip, sometimes even almost subcaudate; stem usually narrower than the leaves: spathe stiffy erect, the inner bract 12–18 mm. long, slightly surpassed by the outer one which is less united-clasping than in *H. Californicus*—usually only 3–4 mm.: flowers on closely erect slightly exserted pedicels 15–22 mm. long; perianth yellow, 8–10 mm. long, the segments apparently mostly five-nerved: stamens 5–6 mm. high, the anthers small, 2–2.5 mm. long: styles 2.5–3 mm. long: capsules ellipsoid, 6–8 mm. long or sometimes narrower obovoid-oblong, and a little longer, 3.5–6 mm. wide: seeds .75–1 mm. in diameter, globose, excavated on one side, finely pitted, often of a semi-transparent reddish color.

Vancouver Island to Whatcom County, Washington, growing on shores of fresh water lakes and flowering from early in July

until after the middle of August. Professor Macoun writes "It grows always in soft mud on the margins of fresh water lakes away from the coast."

WASHINGTON: Whatcom Co., W. N. Suksdorf, flowers July 7; fruit August.

VANCOUVER ISLAND: Lake shores, July 1, 1887, first flowers, and Shawnigan Lake, July 12, 1887, John Macoun; Shawnigan Lake, Aug. 18, 1897, fruit and last flowers, Wm. N. Canby; Sooke, Aug. 3, 1893, John Macoun, fruit and last flowers.

The very close affinity of this plant to *H. Californicus* is much more apparent than its diversity; nevertheless, its much smaller average size throughout and especially its smaller flowers, short anthers and small seeds, taken in connection with its inland distribution and lacustrine habits, is certainly sufficient evidence that it cannot be regarded as the same. The question of varietal relationship in cases such as this must always of course, remain merely a matter of conjecture in the absence of conclusive proof.

The present case is almost fatally complicated by the existence in the coast region of Washington and Oregon of yet another form even more closely related to *H. Californicus*. In a way this plant is intermediate between the two but I cannot conscientiously escape the difficulty it presents by referring it to either, nor do I know how to treat it as a variety; neither can it be ignored. The only consistent course therefore is to give it recognition as a closely allied species, even though its entire validity remains to be established. It may therefore be called to notice as *Hydastylus brachypus*.

Hydastylus brachypus sp. nov.

Mostly low and stout, 8–15 cm. high, but becoming twice as tall, leaves and stem broad, 2–5 mm. wide, sometimes narrower, commonly becoming very dark in drying, the leaves abrupt at the apex or short acuminate, mostly obtusely pointed, the stem often very broadly thin-winged, and abruptly contracted below the spathe; roots very slender and delicate: spathes short, the inner bract 15–20 mm. long, mostly broad above and obtusely rounded and scarious at the apex; outer bract abruptly narrowed to an obtuse point, subequal with or but slightly surpassing the inner one, the broad base rather loosely short-clasping for 2–5 mm., the lower margins conspicuously white or purplish-hyaline; interior

scales ample, usually slightly exserted: flowers apparently medium sized, the anthers 3–4 mm. long: capsules oblong to broadly ellipsoid, 7–10 mm. long, at maturity crowded together on short pedicels mostly 10–15 mm. long, on large plants becoming 20 mm. long, mostly much shorter than the bracts: seeds black, distinctly pitted and umbilicate, small, .75–1 mm. in diameter.

Coast region of Oregon and Washington. Flowering in June and July.

OREGON: Elihu Hall, 1871; Newport, A. Isabel Mulford, June 1, 1892.

WASHINGTON: Near Gray's Harbor, Wilke's Expedition, 1838–42; Chehalis Co., July 6, 1897, F. H. Lamb; Estuary of the Columbia, Nuttall; low hills of the Columbia, Dr. Scouler.

Very near indeed to *H. Californicus* and often equally stout, but mostly lower, with shorter spathes, broader and less unequal bracts, the inner one more obtuse, smaller flowers, very much shorter pedicels and smaller capsules and seeds.

The plant is mostly much stouter than *H. borealis* with broader and more obtuse leaves and bracts and dries darker; the flowers and capsules are rather larger, although the seeds appear to be equally small; in the specimens examined the seeds are darker, less finely pitted and less widely umbilicate, except in size agreeing more nearly with those of *H. Californicus*. Although a larger plant than *H. borealis*, the pedicels, which are relatively much shorter, are in most specimens absolutely so, say 10–15 mm. as against 15–20 mm.

The exact status of the plant can probably be determined only by critical comparative study in the field.

Hydastylus Elmeri (Greene).

Sisyrinchium Elmeri Greene, Pittonia, **2**: 106. 1890.

Nearly allied to *H. Californicus* but smaller and especially more slender, 15–30 cm. high, not turning dark unless carelessly dried. Leaves half the height of the stem or less, 1–3.5 mm. wide: stems very slender, .75–1.5 mm., rarely 2 mm. wide, very narrowly winged or merely margined, like the leaves sometimes minutely serrulate; bracts of the spathe subequal or the outer one slightly the longer, 16–25 mm. long and united-clasping for mostly 5–6 mm., narrowed or short-attenuate to an obtuse point, the rather narrow inner bract scarious obtuse: flowers yellow,

rather closely 5–7-nerved; perianth 10–12 mm. long: stamens 5–7 mm. high: anthers as long as in *H. Californicus* or nearly so, usually 4–5 mm. long; pedicels very slender, 18–23 mm. long, erectly exserted for 1–6 mm.: fruit unknown.

A plant of the Sierra Nevada from northern to middle California, representing there the much larger and stouter *H. Californicus* of the coast.

Though clearly an excellent species as recognized by Professor Greene it can be but poorly understood from existing material. As compared with *H. borealis* it is decidedly more slender with relatively shorter leaves, narrower bracts, longer anthers and more exserted pedicels.

CALIFORNIA: Sierra Nevada, June 28, 1889, Elmer Drew; Type in Herb. Prof. E. L. Greene; Plumas Co., 1876, Mrs. R. M. Austin; Mrs. Ames; Indian Valley, J. G. Lemmon; American Valley, May, 1879, Miss M. A. Plumer.

Hydastylus rivularis sp. nov.

Very small, 3–10 cm. or even 15 cm. high, becoming dull but not turning black in drying, the roots very slender and delicate. Leaves ascending and erect in a short basal tuft, the longer ones 2–6 mm. long, .05–1.5 mm. rarely 3 mm. wide, faintly few-nerved, rather abruptly obtuse, the translucent extreme edges like those of the stem crenulately uneven under a lens; stem straight or outcurved, .05–1 mm. or even 1.5 mm. wide, distinctly thin-winged: spathes straight or deflected, very small, the inner bract 12–17 mm. long, usually surpassing the outer one, the scarious-margined tip obtuse or acutish; outer bract narrowed to an obtuse tip, united-clasping below for 3–6 mm.; interior scales subequal with the bracts, dark-lineate: flowers few, 1–3, on capillary loosely erect or flexuously spreading, much exserted pedicels 15–23 mm. long, surpassing the bracts 5–10 mm., sometimes even twice their length: perianth orange-yellow, 6–8 mm. long, the segments oblong, obtusely pointed, rather openly 5-nerved: stamens 3–5 mm. high, the anthers very small, 2–2.5 mm. long, about the length of the style-branches: seeds apparently few and relatively large.

CALIFORNIA: Fresno Co., Ford of Bubb's Creek, July 5, 1899, in full flower, Miss Alice Eastwood; Mariposa Co., June 3, 1883, J. W. Congdon, first flowers; Eldorado Co., July 13, 1897, first flowers, Ezra Brainerd, wet rocks near Slippery Ford, altitude, 6000 feet.

A diminutive and very delicate plant growing in the wet and sandy or stony margins of fords of mountain streams, and apparently confined to the Sierra Nevadas of middle California.

Its affinity is with *H. Elmeri* and reduced examples of the latter approach it closely, but a wide difference appears between fully developed specimens of the two plants. The very much smaller size and shorter narrower leaves of more delicate texture, the small spathes with elongated inner bract, the small flowers with less close-veined segments, small anthers and mostly flexuously long-exserted pedicels afford a combination of characters which I cannot reconcile with what appear to be the normal characters of *H. Elmeri*.

The species is not unlike the smallest examples of *H. borealis* which, however, is normally altogether larger and stouter, with longer and much broader and more acute leaves, larger spathes and flowers, the outer bract the longer, and but little exserted pedicels.

Hydastylus longipes sp. nov.

Pale dull green and glaucescent, not turning dark when dry, from 15 to 30 cm. high, often in narrow tufts. Leaves numerous, mostly about half the height of the stem, closely erect, rather thin, 1–3 mm. wide, narrowed to an obtuse or acutish usually slightly bent point, the almost hyaline edges smooth: stems from less than 1 mm. to 2.5 mm. wide, the narrow wings smooth-edged: spathes sometimes slightly purplish, rather narrow, 1.5–3 mm. wide, erect or a little bent: bracts thin, often only obscurely nerved, outer one 1.7–2.5 cm. long, connate below for 4–6 mm., narrowly hyaline above to the narrowed and obtusely-pointed tip which surpasses the inner bract 2–6 mm.: inner bract much enclosed, the tip white-scarious and obtuse: longer interior scales equaling the inner bract or nearly so: flowers 3–6 on slender, erect, much exserted pedicels 2–3.8 cm. long, sometimes twice the length of the spathes: perianth 8–12 mm. long, apparently orange-yellow, the segments with fine orange or brownish veins, narrowly oblong, rounded or obtusely pointed at apex: stamens 6–7 mm. high, anthers about 4 mm. long: capsules broadly oblong or obovoid-oblong, slightly retuse, 5–7 mm. high, 4–5 mm. wide, thin-walled, turning dark, erect and contiguous: nearly mature seeds irregularly obovoid or subglobose, 1 mm. in diameter, umbilicate, rugulose pitted.

High mountains of Arizona and northern Mexico, flowering from early July until after the middle of August.

ARIZONA: San Francisco mountain, Aug. 18, 1889, fruit and last flowers, F. H. Knowlton; Aug. 4, 1898, 9000–10,000 ft. in meadows, Dr. D. T. MacDougal; Rincon Mts., 7500 ft., 1891, G. C. Neally; Harts Little Spring, July 14, 1892, full flower, E. O. Wooton; J. W. Toumey.

MEXICO: Chihuahua, Sierre Madre, 7500 ft., July 18, 1899, full flower; communicated by Prof. E. O. Wooton.

The aspect of this plant is nearest that of *H. Elmeri* but it is more tufted and leafy with rather broader stem but narrower leaves, rather more prolonged and narrower outer bract, much more exserted pedicels apparently also with less closely and distinctly lineate perianth segments and somewhat shorter anthers.

Hydastylus Schaffneri (Watson)

Sisyrinchium Schaffneri Watson, Proc. Am. Acad. **18**: 160. 1883.

Low, in erect or somewhat depressed leafy tufts, 4–10 cm. high, from short rootstocks bearing pale and apparently soft and somewhat thickened simple roots, dull green, discoloring when dry. Leaves equaling the stems or shorter, very narrow, 0.5–1.5 mm. wide, rather abruptly membranously expanded to a relatively long conduplicate base, narrowed to a very obtuse sub-cartilaginous tip, apparently thickish, the rather obscure fine nerves becoming somewhat prominent in drying, the intervals minutely cross-rugulose or even subscabrellous, the edges smooth or nearly so: stems erect or spreading, narrowly wing-margined, .05–1 mm. wide, rugulose like the leaves and smooth edged or nearly so: spathes mostly deflected, small, 10–15 mm. long, 1.5–2 mm. wide, the bracts subequal or usually the outer one slightly the longer, rugulose, the outer one attenuate to an obtuse tip or sometimes more abruptly narrowed, united-clasping for 3–5 mm., the margins below narrowly hyaline: inner bract less narrowed, scarious obtuse at apex: interior scales subequal with the bracts: flowers few, 3–5, on slenderly exserted, erect or sub-spreading pedicels 15–23 mm. long, exserted 5–8 mm.: perianth yellow, distinctly lineate, about 6–8 mm. long: anthers 2.5–3 mm. long.

Central Mexico, San Luis Potosi, 6000–8000 ft. altitude, no. 881, C. C. Parry and Ed. Palmer, 1878, no. 527, Shaffner.

I have examined three sheets of this type material, two of no. 881. It does not appear that the plant has since been collected.

Hydastylus parvus sp. nov.

Similar to *H. Schaffneri* (Watson) of Mexico, but with broader leaves and stem and larger spathes, the flowers on more exserted pedicels and larger with longer anthers.

Leaves shorter than the stems, mostly 1.5–2 mm. or even 2.5 mm. wide, apparently thinner and rather more distantly nerved than in *H. Schaffneri* and only obscurely if at all rugulose: stem 1.5–2 mm. wide, wing-flattened: spathes 13–18 mm. long, distinctly broader than in *H. Schaffneri*, 2.5–3 mm. wide, the bracts subequal, but often the inner one slightly the longer, the outer one rather more loosely united-clasping than in *H. Schaffneri* and less attenuate, the inner one broader above and more scarious-obtuse; pedicels 23–28 mm. long, usually becoming nearly twice the length of the bracts, erect or diverging: perianth 7–10 mm. long; anthers 3.5–5 mm. long.

MEXICO: "low valley near Saltillo, March 22, 1847, no. 340, Dr. Gregg" just in flower. Type in Herb. Miss. Bot. Gard. and Herb. Columbia.

Hydastylus cernuus sp. nov.

Caespitose in small open tufts 7–18 cm. high from a cluster of pale and delicate fibrillate roots, dull green and glaucescent, turning brown or blackish when dry. Leaves membranously equitant at base, sometimes equaling the stems but mostly shorter, very thin with delicate rather distant nerves often with a fainter alternating series, 1.5–4.5 mm. wide, acuminate to an obtusish point, sometimes obscurely roughened on the sides above, the almost hyaline edges smooth or minutely serrulate: stems erect or ascending, slender, .75–1 mm. wide, delicately wing-margined, the edges smooth to serrulate: spathes erect; outer bract much prolonged, mostly twice the length of the inner one or even longer and surpassing it 5–25 mm., 15–40 mm. long, attenuate to an obtuse point or foliaceously broadened and acuminate, united-clasping for about 5 mm. at base; inner bract 10–15 mm. long, narrow, acutish to obtuse, usually much concealed; interior scales narrow, shorter than the inner bract: flowers very small, 3–5 mm. long, pale yellow, the segments somewhat obtuse, dark-lineate: anthers linear, .05–1 mm. long, the stamens 1.5–2 mm. high: pedicels capillary, becoming 12–18 mm. long, finally slenderly exserted and recurved, the capsules mostly cernuous: capsules pale brown with very thin almost membranous walls taking the impression of the contained seeds, subglobose and 3–5 mm. high to somewhat pyriform and rather longer; seeds mostly 2–4 in each row, sometimes more,

large, 1.25–1.5 mm. in diameter, subglobose to broadly oblong, semi-transparent brown, deeply close-pitted and excavated-umbilicate.

MEXICO: Chihuahua; Sept. 7, 1887, fruit mature and last flowers; "High plains between Cusihuiriachic and Guerrero, C. G. Pringle; wet places, Sierra Madre, Oct. 11, 1888, fruit mature and last flowers," C. G. Pringle.

Printed labels refer the older collections of this plant to *H. Schaffneri* from which, however, it may be readily distinguished by much broader leaves, elongated primary bracts and much smaller flowers with very short anthers and recurved pedicels.

Hydastylus subcernuus sp. nov.

Caespitose in small tufts, 6–15 cm. high, the leaves mostly erect, the stems erect or ascending, turning dark brown in drying; roots pale, very delicate and fibrillate. Leaves about half the height of the longer stems, mostly 1.5 mm. wide (1–2 mm.), thin and delicately open-nerved, tapering to an obtuse point, the edges smooth to distantly denticulate: stem 2–15 cm. high, .05–1.5 mm. wide, delicately wing-margined, the thin edges minutely denticulate or usually so: spathes small, the narrow bracts subequal or usually the outer one a little surpassing the inner, sometimes as much as 6 mm. longer, 13–22 mm. long, united-clasping for 5–6 mm., attenuate to an obtuse point; inner bract narrowly obtuse-pointed; interior scales nearly equaling the inner bract: flowers 3–5, small, perianth about 5 mm. long, yellow, delicately dark lineate: stamens about 3–50 mm. long; pedicels capillary, 15–20 mm. long, finally exserted and recurved spreading: capsules less membranous than in *H. cernuus* but similarly moulded over the contained seeds, mostly obovoid-pyriform and 5–6 mm. high: seeds few in a row, larger and rather darker and more coarsely pitted than in *H. cernuus*, 1.5–1.75 mm. in diameter, widely excavated on one side or more or less acetabuliform.

LOWER CALIFORNIA: Sierra de la Laguna, January 22, T. S. Brandegee, type in Herb. Cal. Acad. Sci.

Nearly related to *H. cernuus*, but with narrower leaves, much shorter outer bract, larger flowers with much larger anthers, pedicels less exserted and recurved, capsules rather larger, seeds larger and more coarsely pitted and acetabuliform.

Hydastylus serrulatus sp. nov.

Growing in nearly simple tufts, 14–32 cm. tall, from very deli-

cate and fibrillate nearly simple roots, rather bright transparent green, discoloring but little when carefully dried. Leaves acuminate to an acutish point, 2–5 mm. wide, thin and somewhat translucent, very delicately nerved, the main nerves rather distant with 1–3 fainter nerves in the intervals, rather distantly reticulated with minute cross-veinlets, the edges sharply fine-serrulate: stems 2–5 mm. wide, the stem proper very narrow, the wings very broad and thin, nerved and semi-transparent like the leaves and with serrulate edges: spathes mostly narrower than the stem: outer bract lanceolate-attenuate, 25–37 mm. long, surpassing the inner one 3–12 mm., united clasping 6–8 mm. at the flattened and sharply two-edged base: inner bract attenuate and acutish, 20–25 mm. long: interior scales more than three-quarters the length of the inner bract: capsules 3–6, large, pyriform, narrowed to an almost substipitate base, 8–10 mm. long, on slender, somewhat flexuously spreading pedicels about 25 mm. long: seeds black, subglobose, about 1.5 mm. in diameter, strongly pitted, excavated-umbilicate.

A species very distinct from any of the others here described, characterized especially by the very thin and reticulated semi-transparent leaves, broadly-winged stem and large pyriform capsules.

MEXICO: Orizaba, "in the mountains," Botteri, no. 1856. Type in Herb. Dr. Charles Mohr; Michoacan, 1857, Dr. Carlos Sartorius, Herb. Dr. Charles Mohr.

Hydastylus translucens sp. nov.

Very similar to *H. serrulatus*: glaucescent, the spathes often purplish tinged, 15–25 cm. high, showing more or less discoloration from drying, leaves equaling the stems or nearly so, 2–3.5 mm. wide: as compared with those of *H. serrulatus* longer and narrower, much more slenderly attenuate and even thinner and more translucent, with fewer cross-veinlets, the edges not distinctly serrulate, but wholly smooth except near the apex, or with some very minute or obscure denticulations: stem 1–1.25 mm. wide, the very thin translucent wings much narrower than in *H. serrulatus* and smooth-edged or nearly so: spathes not narrower than the stems, usually somewhat broader, the outer bract usually foliaceously prolonged, 30–47 mm. long, surpassing the inner one 10–25 mm., united-clasping 8–10 mm. above the sharply two-edged base: inner bract 17–22 mm. long, narrow, obtuse or emarginate: interior scales longer than in *H. serrulatus*, equaling the inner bract or nearly so: pedicels very

slender and long-exserted, more or less spreading and finally recurved for about half their length, 25–37 mm. long: capsules 3–5, obovoid-oblong or somewhat pyriform, smaller and thinner-walled than in *H. serrulatus*, about 6–7 mm. long: seeds larger than in any other species of the genus at present known, 2–2.5 mm. in longer diameter, flattened acetabuliform, strongly reticulate-pitted.

LOWER CALIFORNIA, Sierra de la Lagura, January 24, some fruit mature. T. S. Brandegee, Herb. Cal. Acad. Sci.

Closely related to *H. serrulatus*, *H. cernuus* and *H. subcernuus* but unmistakably a distinct species, as clearly shown by its much larger seeds, longer outer bract and longer pedicels without regard to other characters. These four plants form a group of closely related species constituting a section of the genus rather obviously distinct from the more northern group represented by *H. Californicus*. The group characters especially to be noted are very thin membranous leaves showing cross-reticulations between the nerves, although these are few or obsolete in *H. cernuus* and *H. subcernuus*, more or less spreading or recurved pedicels and very thin-walled, mostly pyriform capsules.

Some Notes on Saxifraga and Primula

By K. M. Wiegand

Saxifraga bronchialis L.

Densely caespitose, glabrous: stems divaricately ascending, rather stout (4–9 cm. high, 1 mm. diameter), rarely purplish: leaves thick and firm, densely clustered at the base, 7–12 mm. × 1.75–2.5 mm., oblong-linear, not narrowed below, abruptly acute and white cuspidate, spinulosely ciliate to the apex or nearly so, cauline similar but much smaller (5–6 mm. × 1–1.5 mm.): flowers few (1–7), in a flat-topped sparingly glandular cyme, on short (8 mm. or less) rather stout peduncles and sometimes in the larger plants appearing secundly racemose: calyx-lobes short-oblong or oblong-ovate (2–2.25 mm. long), obtuse or acutish: petals pale greenish-yellow, orange spotted below the middle (6.5 mm. × 2.75–3 mm.), broadly elliptical or oval, rounded at the apex, broadly unguiculate at the base: stamens equaling or slightly exceeding the corolla: ovary large and prominent, oblong-ovate: styles ⅔ the length of the ovary.

Across northern Siberia to Alaska.

Specimens examined: Emma Harbor (Capt. Scammon, West. U. Teleg. Exp. Exped. 1865–66); Plover Bay, lat. 64° (E. E. Smith, same Exped.); Disenchantment Bay (Funston, no. 91).

The specimens of *S. bronchialis* which have come to the herbarium from the far Northwest are so distinctly different in appearance from those commonly obtained upon the mountains of Idaho, Colorado and New Mexico that investigations were instigated to determine the significance of these differences. The numerous and marked differential characters given below leave no doubt that the two forms are specifically distinct.

The locality given by Linnaeus for this species was Siberia. No specimens from that country were available for this study, but the description given by Ledebour and others show that the Alaskan specimens are identical with the Asiatic.

The var. *chelerioides* Engler is found on the northwest coast, and differs from the type in being more delicate, with shorter more obtuse densely imbricated leaves, and smaller flowers, with smaller more nearly sessile petals.

Saxifraga austromontana sp. nov.

Densely caespitose, glabrous, the rootstocks densely scaly-bracted: stems divaricately ascending (7–18 cm. high, .75 mm. thick), slender, usually purplish: leaves thick and firm, crowded on the caudex (7–10 mm. × 1.5 mm.), linear oblong, slightly narrowed below, gradually acute or almost acuminate at the apex, terminated by a stout white bristle, shining, spinulose-ciliate from the base to within 1.5 mm. of the tip: cauline leaves much smaller, 4–6 mm. long, linear-subulate: flowers numerous, 4–12 or even more, on slender slightly glandular peduncles (4–10 mm. long), in a convex or often oblong open cyme, the lower sometimes quite distant: calyx-lobes 2 mm. long, ovate, obtuse, rarely apiculate, sparingly glandular: petals white, spotted with orange dots below the middle, and with deep-purple dots above, elliptic-oblong (5.5 mm. × 2 mm.), broadest just below the middle, obtuse at the apex, rounded and somewhat truncate at the base, not at all unguiculate: stamens $\frac{1}{5}$–$\frac{1}{4}$ shorter than the petals: ovary deltoid: styles very short, not over $\frac{1}{2}$ the length of the ovary.

Cascade Mountains of Washington to Alberta, and southward along the Rocky Mountains to New Mexico.

Specimens examined: Cascade Mts. (Lyall); Tunnel Mt., Alberta (W. C. McCalla, no. 2287 (1899)); Colorado (Parry, no. 168; Hall and Harbour, no. 197; Wolf, no. 802); New Mexico (Heller, no. 3775).

This species differs from *S. bronchialis* in its more subulate, darker green leaves, with fewer ciliae near the apex; more slender, often purple stems; many-flowered convex or oblong cymes, more slender pedicels; smaller, white petals with purple dots above, and not unguiculate at the base; stamens shorter than the corolla; and smaller capsules with much shorter styles. It probably includes all of the so-called *S. bronchialis* from the Rocky Mountains south of Alaska.

Primula Maccalliana sp. nov.

P. Mistassinica Hook. Bot. Mag. *t. 2973*. Not of Michx.

Low but not very slender (4–12 dm. high): leaves from broadly spatulate to obovate-cuneate, mostly quite broad, the larger usually sessile by a wedge-shaped base, the smaller rarely contracted into a short margined petiole, thick and rather fleshy, mostly glabrous and pale green above, more or less mealy beneath, obtuse

or rounded, and crenate at the apex, entire below, 2–2.5 (rarely 3) cm. long: umbels 2–several-flowered, sparingly farinose: involucral bracts subulate, acute, 5 mm. long, somewhat dilated at the base and slightly auriculate; pedicels short and stout, about 4 (rarely 7) mm. long: calyx glabrous or nearly so, narrowly obconic, 4.75–5 mm. long, the lobes narrowly oblong-ovate or lanceolate, acutish, about one-half the length of the tube: corolla rather large, deep rich blue, rarely paler, not flesh-colored nor pink, orange eye large and conspicuous, tube yellow, scarcely exceeding the calyx, the lobes 5–6 mm. long, broadly obcordate, the base gradually, or more rarely abruptly contracted: fruit not seen.

Eastern slope of the Rocky Mountains in British America.

Specimens examined: "Along warm streams below the Sulphur springs," Banff, Alberta, altitude 4500 feet (W. C. McCalla, no. 2423 (1899)).

In the Botanical Magazine, *t. 2973*, Hooker figured a plant which he considered to be the true *P. Mistassinica* of Michaux. This plate was probably drawn from plants grown from seeds collected by Drummond and Richardson as these travelers were cited as having brought back seeds of this species on their return from the Canadian Northwest. The figure and the description leave little doubt that Mr. McCalla's plant is the one described by Hooker, and not the eastern plant of Michaux.

In general appearance *P. Maccalliana* resembles *P. farinosa* in the rather dense umbel, stouter habit and densely rosulate, pale, farinose, cuneate leaves; and seems to be somewhat intermediate between it and *P. borealis*. It differs from the former in its smaller size, nearly sessile short leaves, and much smaller calyx with proportionally longer more acute lobes. *P. borealis* is smaller and more slender with smaller narrowly spatulate long-petioled leaves, long-peduncled flowers, and subulate acutish calyx-lobes which are dark-purple spotted. *P. Sibirica* is much larger with slender-petioled leaves and longer calyx with short obtuse lobes, also dark-blotched.

From the eastern *P. Mistassinica* it differs quite markedly in its stouter habit, broader and more farinose leaves, short-pedicelled flowers, larger acute-lobed calyx, and large bluish, not pink or flesh-colored, corolla with tube scarcely longer than the calyx, and with a very prominent yellow eye.

P. Maccalliana is said by the present collector to be common in Alberta where it goes under the name *P. Mistassinica*. Doubtless it has a wide range in western British America. The mature capsule was not seen, but in Hooker's plate above referred to it is figured as being one third longer than the calyx.

CORNELL UNIVERSITY.

New and Noteworthy Northwestern Plants.—IV

By C. V. Piper

Amelanchier cuneata sp. nov.

Shrub about 2 meters high with dull grayish bark even on the branchlets; youngest twigs with a somewhat appressed white pubescence: leaves elliptic to obovate, few-toothed toward the obtuse apex, mostly attenuate to the more or less cuneate base, sparsely pubescent on each side when young, pale green, rather thin, 2–3 cm. long; petioles slender, a little shorter than the blades; stipules setaceous: racemes 10–20-flowered, the pedicels about 1 cm. long: calyx somewhat pubescent, the acute triangular-lanceolate lobes as long as the tube: petals oblanceolate, obtuse, 12 mm. long: stamens 20: fruit not seen.

In sage-brush land, Ellensburg, Wash., *C. V. Piper*, no. 2173, collected May 20, 1897.

Nearest *A. alnifolia* Nuttall, but easily distinguished by the pale twigs and cuneate leaves.

Potentilla gracilipes sp. nov.

Perennial, tufted: caudex stout, vertical, simple or branched above, 8–10 cm. long, 1 cm. in diameter, more or less covered with old petioles or pitted-scarred where they have fallen off: leaves densely imbricated at base, oblong in outline, pinnate of 9–11 leaflets or divisions, equally silvery sericeous on both sides, 4–6 cm. long; leaflets sessile, broadly cuneate, the lowermost entire, the other 3-cleft at apex, the lobes more or less unequal; petioles flattened, mostly concealed: peduncles few, 1-flowered, slender, pubescent, erect, 6–8 cm. high, bearing two bracts above, these ovate, sessile, acutish, simple or 3-lobed: flower 2–2.5 cm. in diameter: hypanthium rotate, appressed, pubescent, the calyx-lobes broadly ovate, acutish, 6–7 mm. long, the bractlets elliptic, much smaller: petals orbicular, short-clawed, bright yellow, 1 cm. long, well exceeding the calyx-lobes: stamens 50–60, the filaments glabrous, but with some villous pubescence at and near their bases: carpels numerous, densely silvery villous: styles terminal, as long as the carpel, more or less divergent: mature akenes not seen.

Face of north cliffs, Blue Mts., Oregon, at the head of Anthony's Creek, altitude about 8000 ft., in July, 1899, *W. C. Cusick*,

no. 2246. Nearest *P. Breweri* Watson, but easily distinguished by its 1-flowered peduncles and villous carpels. Apparently it is the only North American species with pinnate leaves and strictly one-flowered peduncles.

Saxifraga Columbiana sp. nov.

Scapes rather stout, terete, erect, glandular, usually solitary from the caudex: leaves all radical, ovate to elliptic-oblong, obtuse, entire, the blades 2–6 cm. long, gradually narrowed into a somewhat shorter petiole: inflorescence a branched narrowly pyramidal cyme, the cymules rather dense: bracts lanceolate or linear: flowers 5–6 mm. in diameter on stout pedicels: calyx-lobes triangular ovate, obtuse, at length reflexed: petals whitish, elliptic or oblong, 1-nerved, slightly narrowed at base, shorter than the calyx lobes: filaments subulate, about equaling the petals: anthers pale yellow: carpels separate, divergent at apex.

Nearest *Saxifraga plantaginea* Small, which is a larger plant in every way. Both these species differ from others of the *integrifolia* group in that the petals are shorter than the calyx lobes. In the species here described the petals are very different in shape and size from those of *S. plantaginea.*

The following specimens have been examined:

WASHINGTON: Near Fort Colville, *Lyall* in 1861; "upper Oregon," *Geyer*, no. 625; Pullman, *Piper*, no 1508 (type).

IDAHO: Near Lewiston, *Sandberg, MacDougal* and *Heller*, no. 73, April 30, 1892; Clearwater River, *Spalding.*

OREGON: Union Co., *Cusick* in 1879.

Saxifraga apetala sp. nov.

Scapes stout, terete, erect, solitary, glandular pubescent, 1–2 dm. tall: leaves all radical, oval, oblong or ovate, obtuse, entire or obscurely denticulate, glabrous except the ciliate margin, the blade 1–3 cm. long, narrowed into a broadish petiole a trifle shorter: inflorescence dense, 1–2 cm. long: flowers very short-petioled, green: calyx-lobes broadly ovate or suborbicular, obtuse, erect, 2 mm. in length, the tube twice as long: petals wanting: stamens ten, the anthers pale yellow on subulate filaments nearly as long as the calyx-lobes: carpels disciform when young, the margin crenulate: mature fruit not seen.

The type is *G. R. Vasey's* no. 358, collected somewhere in Washington in 1889; the same plant has been found by *Whited* in

the Kittitas Mts., twenty miles north of Ellensburg. The species is one of the *S. integrifolia* group and is easily distinguished by its apetalous flowers and long calyx-tube.

Saxifraga Idahoensis sp. nov.

Stems slender, erect, terete, glandular, 2–3 dm. high, usually several from a stout caudex: leaves all radical, the blades ovate, obtuse, coarsely dentate, 2–6 cm. long, abruptly contracted into a broad flat petiole as long as the blade, glabrous or with a few rufescent hairs on the margin and lower side: inflorescence a much-branched cyme, the branches assurgent: flowers numerous, 3 mm. in diameter, on slender strongly divaricate pedicels: bracts lanceolate or subulate: calyx-lobes ovate, obtuse, free nearly to the base, sharply reflexed even in early anthesis: petals white, orbicular, scarcely clawed, mostly 3-nerved toward the apex, not exceeding the calyx-lobes: filaments subulate, persistent, at length exceeding the petals: anthers pinkish: carpels free from each other, divergent above: the style short and stout.

All the specimens seen are from western Idaho.

"Clearwater," *Rev. Spalding.*

Island in the Clearwater above Lewiston, *Sandberg, McDougal* and *Heller*, no. 93, May 2, 1892.

Kendrick, *Henderson*, no. 2672, April 21, 1894, and no. 4588, April 26, 1897 [type].

Related to *S. occidentalis* Watson and *S. reflexa* Hook. Its nearly glabrous leaves, much branched inflorescence and small flowers easily distinguish it. Abnormalities in the structure of the flowers are of frequent occurrence.

Townsendia alpigena sp. nov.

Perennial, caespitose from a usually multicipital caudex, 2–4 cm. high: root stout, vertical: leaves numerous, clustered, spatulate, acutish, thickened at the margin, appressed strigulose when young, more or less glabrate at maturity, 1–2 cm. long: peduncles one or two bracted, 1 cm. high, hirtellous: heads solitary on the peduncles, 1–1.5 cm. in diameter, the involucre campanulate, of about three ranks of well-imbricated scales, these oblong, acute, scarious-margined, more or less pilose on the back, sometimes pink-tinged: rays 12–18, dark blue, linear, acute, 1 cm. long: pappus of the disk-flowers bright white, scabrous, multisetose, as long as the akene, that of the ray-flowers similar, but a trifle shorter: akenes flattened, those of the disk usually glabrous, ex-

cept at the very base, those of the rays more hairy; hairs soft, as long as the width of the akene, many of them bidentate at apex, the teeth spreading or recurved.

Wallowa Mts., northeastern Oregon, 7000–8000 feet altitude, *W. C. Cusick*, no. 2294, collected July 31, 1899. The species is apparently nearest to *T. Arizonica* Gray.

ERIGERON CHRYSOPSIDIS Gray, Syn. Fl. **1**: 210. 1884

Erigeron ochrolcucus hirtellus Gray, Proc. Am. Acad. **16**: 90. 1880.

The type sheet of this species contains the four following specimens from which the description in the Synoptical Flora was drawn up, namely:

"Mts. Oregon, Cusick, 1877." "Interior of Oregon, Nevins, 1877." "In stiff clay on mountain slopes, Rev. R. D. Nevins, 1877." "Stony hills, John Day's Valley, E. Oregon, May, 1880, Howell Bros." No. 200; also a fifth collection by Suksdorf, no. 349, "Plains, southwest of Morgan's Ferry, Yakima Co., Wash., June 7, 1884." This last specimen is the basis for the note in Syn. Fl. Supp. I., 447, 1886. It is clearly a different plant from the others, but agrees exactly with several later collections. A careful study of DeCandolle's description of *Chrysopsis hirtella*, Prodr. **5**: 327, leaves scarcely a doubt that the Douglas plant from the Columbia River there described is the same as the Suksdorf plant. This is discussed below. Of true *Erigeron Chrysopsidis*, Gray, excellent specimens have recently been distributed by *Mr. W. C. Cusick* under no. 2187, from the Blue Mts., Oregon. These specimens have leaves sometimes 8–10 cm. long, but always truly spatulate. The heads of this species are 2–3 cm. high, the rays 2 cm. long.

Erigeron Chrysopsidis brevifolius var. nov.

Densely caespitose, bearing scapes 4–6 cm. high: leaves 1–1.5 cm. long: heads 2 cm. high, the rays 1.5 cm. long, golden yellow.

Subalpine ridges of the Wallowa Mts., northeastern Oregon, 7000 ft. altitude, *W. C. Cusick*, no. 2270, July 27, 1899. Differs from the type in being smaller in every way and having relatively much shorter leaves.

Erigeron curvifolius n. n.

Chrysopsis hirtella DC. Prodr. **5**: 327. 1836.

Perennial with several or numerous branches from a woody caudex, 5–10 cm. high: root straight, simple: leaves not densely crowded, linear, entire, acute, sessile, more or less curved, 1.5–3 cm. long, 1–2 mm. wide, hirtellous with white hairs, the midrib broadened and whitish toward the base: flowering stems numerous, slender, appressed hirsute, scarcely exceeding the leaves, monocephalous, or rarely with a second smaller head: heads about 1 cm. high: involucre of 25–30 linear acuminate hispidulous bracts, all at length reflexed: rays 30–40, pale yellow, linear, 1 cm. long: achenes appressed hirsutulous; outer pappus of very short setae; inner nearly equaling the floret, which with the akene is 4 mm. long: receptacle with the alveoli wanting or very obscure, minute setae appearing in their places especially near the margin.

Readily distinguished from *E. Chrysopsidis* Gray by the much smaller heads and florets, very different leaves and by the receptacle not being alveolate.

It is a plant of the dry sandy plains of the Columbia and its habitat taken in connection with the linear leaves and peculiar receptacle renders it nearly certain that this plant, and not the subalpine *Erigeron Chrysopsidis* Gray, is the *Chrysopsis hirtella* of De Candolle.

The following specimens, all from Washington, have been seen viz.: Morgan's Ferry, Yakima Co., *Suksdorf*, June 7, 1884; Washtucna, *Elmer*, no. 1036, June, 1898; Pasco, *Hindshaw*, May 25, 1896; Pasco, *Piper*, no. 2993, May 25, 1899; Connell, *A. B. Leckenby*, June 18, 1897.

Pentstemon Gairdneri hians var. nov.

Shrubby and decumbent below, the flowering shoots erect or nearly so, 2–3 dm. high, cinereous puberulent, or above glandular: leaves rather numerous, alternate, linear or linear-spatulate, sessile, acutish, revolute, more or less curved, ascending, 2–3 cm. long, 2 mm. wide: flowers 10–20, racemose or somewhat paniculate, rather strict; bracts lanceolate, acuminate, about 1 cm. long: calyx 1 cm. long, the lobes ovate, acuminate, subequal, free quite to the base, not equaling the corolla tube: corolla red, minutely glandular, 2.5 cm. long, tubular-funnelform, broadly dilated in the naked throat, bilabiate, the prominent lobes broadly rounded, sub-

equal, widely spreading: stamens included in the tube of the corolla, the sterile filament pilose for the upper third; anther cells dehiscent the whole length and explanate: style about equal to the stamens, slightly exceeding the calyx lobes.

EASTERN WASHINGTON: *G. R. Vasey*, no. 432 in 1889 (type). Ellensburg, *Piper*, no. 2702. Wenatchee, *Whited*, no. 36. Tampico, *Flett*, nos. 1184 and 1187.

The original specimens of *Pentstemon Gairdneri* were collected in the Blue Mts., Oregon, by Douglas, and the species is well represented by *Cusick's* no. 1637, from that region. The variety is the commoner form in central Washington and is readily distinguished by its larger corolla with spreading limb and larger calyx lobes. Intergrading forms are not rare.

Pentstemon confertus globosus var. nov.

Erect, 2–3 dm. high, perfectly glabrous throughout, pale green: radical leaves oblong, acute, entire, 6–10 cm. long, attenuate into a petiole 1–2 cm. long; cauline leaves 3 or 4 pairs, the lower pair usually short-petioled, the others sessile, all similar to the radical but becoming broader upwards, the uppermost commonly ovate: inflorescence a dense head-like panicle of many short-pedicelled flowers, rarely with a second verticillate cluster below: calyx lobes nearly distinct, ovate-acuminate, narrowly scarious-margined, entire or obscurely dentate, nearly one half as long as the corolla: corolla intense blue, nearly 2 cm. long, tubular, bilabiate, the lower lip sparsely villous within, the lobes rounded, entire, subequal, one fourth as long as the tube: stamens included, the sterile bearded above the middle: anthers splitting their entire length but not explanate, the cleft ciliate margined.

Wallowa Mts., northeastern Oregon, altitude 6000–7000 ft., *W. C. Cusick*, no. 2328, Sept. 1, 1899.

Strikingly different from *P. confertus* Dougl. or any of the numerous forms of var. *coeruleo-purpureus* Gray, but lacking any distinct morphological characters. Except for the perfectly glabrous inflorescence, it would be referred rather to *P. attenuatus* Dougl., its flowers being fully as large as in that plant.

Pentstemon Newberryi rupicola var. nov.

A much-branched densely caespitose decumbent shrub, 5–8 cm. high, pilose-puberulent below, the inflorescence glandular-viscid: leaves numerous, opposite, ovate or orbicular, more or less dentate, obtuse, glaucous, with a persistent bloom, thick, not turn-

ing black in drying, .5–1 cm. long, attenuate at base into a short petiole: flowers 3–6 in a rather close corymb: bracts of the peduncles ovate or orbicular, entire, obtuse, retuse or acute, about 4 pairs: calyx lobes distinct, equal, ovate, acute, ciliate, glandular, about 7 mm. long: corolla 3 cm. long, bright rose crimson, naked in the throat, decidedly ventricose, somewhat bilabiate, the lobes oblong, obtuse, rather short: fertile anthers barely extruded, white-woolly: sterile filament short, glabrous.

Dry rocky cliffs, Mt. Rainier, 7500 ft. alt., *Piper*, no. 2086 (type); Goat Mts., Wash., 3000–6000 ft. alt., *Allen*, no. 130.

This plant is very different from *P. Newberryi* Gray in its depressed habit, thicker leaves and larger ventricose corolla. I should not hesitate to call it a species were it not for the fact that on Mt. Adams occurs a very similar plant, but with the tubular corolla of *P. Newberryi*, and thus forming a transition to it.

Castilleia rustica sp. nov.

Stems erect, apparently from a decumbent woody base, simple, or more commonly with erect branches, minutely white pubescent throughout and somewhat glandular above: leaves narrowly lanceolate, rather few, sessile, mostly entire: bracts 3–5-cleft, only the lower exceeding the flowers, greenish: spike dense, 2–8 cm. long: calyx 10 mm. long, short-villous, equally cleft before and behind, the segments somewhat shorter than the tube, each divided half way into similar triangular acuminate teeth: corolla greenish-yellow, 15 mm. long, glandular-puberulent above, the blunt galea more than half as long as the tube; lower lip very small, one-fourth as long as the galea, saccately 3-lobed, the free portions acute, one third as long as the saccate enlargements: stigma capitate, protruding: stamens included.

Rocks of the Wallowa River, northeastern Oregon, 6000 ft. alt., *W. C. Cusick*, collected August 7, 1899. A homely species with some affinity to *C. Lemmoni* Gray.

Castilleia rubida sp. nov.

Decumbent, 2–10 cm. high, the numerous simple stems from a stout woody caudex which is continued into a long tap-root: stems and leaves pubescent with short white crisp hairs and also minutely and densely glandular, especially in the inflorescence: leaves sessile, linear or lanceolate, entire or more frequently 3-cleft or 3-parted, 1–2 cm. long; bracts similar to the upper leaves, 3–7-cleft, mostly tinged with dull purple: flowers in a short dense

spike: calyx tubular, more or less villous, 1 cm. long, equally cleft before and behind, the segments one half as long as the tube, each again deeply cleft so that the four triangular acuminate calyx-lobes are subequal: corolla greenish except the margins of the galea and the lower lip which are dull purplish, tubular, minutely glandular, 12 mm. long, the blunt galea only one third the length of the tube, slightly exceeding the saccately 3-lobed lip, the free portions of which are oblong, obtuse, and slightly longer than the ventricosities, each of which bears two smaller swellings on its summit: anthers orange-yellow, slightly extruded: stigma capitate, 2-lobed, extending beyond the galea.

Wallowa Mts., northeastern Oregon, 9000 ft. alt., *W. C. Cusick*, no. 2094, collected August 23, 1898, and again July 28, 1899. The 1898 plant was distributed as "*Castilleia Lemmoni* Gray?" to which the new species has some relation. The calyx and corolla are, however, very different.

Castilleia angustifolia Whitedii var. nov.

Stems clustered on a woody caudex, erect, 2–3 cm. high: leaves all entire, lanceolate, 2–3 cm. long; bracts broader than the leaves, the uppermost 3-lobed; otherwise as in the type.

Wenatchea, Wash., Kirk Whited, no. 1141, collected June 11, 1899. Particularly interesting as being markedly different from all its immediate allies in having entire leaves.

Salix bella sp. nov.

Shrub 2–4 meters high with slender erect stems, the bark gray and smooth: branches erect or little spreading; branchlets shining, yellow, very brittle, glabrous or sometimes puberulent, slightly glaucescent: leaves lanceolate or oblong, or oblong-obovate, mostly acute, 3–6 cm. long, or on vigorous young shoots even 12 cm. long, about one fourth as wide, above green and sparsely appressed puberulent, beneath velvety with a persistent silvery tomentum, entire or obscurely repand-crenulate; midrib yellow, conspicuous, bearing about 15 pairs of primary veins, stipules commonly present, free, lunate, acute, .5 cm. long or less: aments sessile, appearing before the leaves, or the pistillate sometimes on a very short peduncle that bears 2 or 3 small leaves: pistillate aments stout, oblong, 2–3 cm. long, or in fruit 4–6 cm., densely flowered; scales black, persistent, oblong, obtuse, 1.5 mm. long, villous with white hairs twice as long; capsules narrowly and somewhat angularly pyriform, attenuate, acute, grayish-sericeous,

6–7 mm. long, including the style: style 1.5 mm. long: stigmas thick, glandular, broad, entire or two-lobed or cleft; pedicel 1–2 mm. long: nectary small, one half as long as the pedicel: staminate aments 1–2 cm. long, densely flowered; scales black, ovate, usually acute, persistent, 2 mm. long, densely villous with long tawny hairs: stamens 2, usually unequal, twice as long as the scale: filaments free: anthers yellow: nectary small, about one fourth as long as the scale.

First detected near Garrison, Whitman Co., Wash., by Prof. L. F. Henderson. In this place only a dozen or more plants occur, but the species is abundant along the north fork of the Palouse between Colfax and Palouse, Wash., and along the Potlatch River near Collins, Idaho; also at Jansville, Idaho.

This species is one of the obscure *Salix pellita* group and apparently the only one of which complete material has been collected. Its relationship is with *S. candida*.

From *S. pellita* and at least so far as the Lyall type specimen is concerned, *S. bella* differs in these important particulars: the pistillate aments are sessile or nearly so; the capsule is smaller and more sericeous; the scale is black, obtuse, long villous instead of brown, acute, and sparsely pilose; and the stipules are well developed. The leaves too are quite different.

Salix subcoerulea sp. nov.

Shrub about 2 meters high: branchlets dark, glabrous, bluish with a bloom that easily rubs off: leaves oblong-lanceolate, occasionally oblanceolate, acuminate, acute at base, entire or obscurely crenulate, above green and minutely pubescent, beneath silvery appressed pubescent but scarcely tomentose, 2–5 cm. long, 1 cm. wide; pedicels short, about .5 cm. long: stipules obsolete: pistillate aments appearing with the leaves, pedunculate, usually with one or more small leaves at base, 2.5–4 cm. long, less than 1 cm. thick, erect, straight or cernuous: capsules short-pedicelled, pyriform, silvery sericeous, 2–3 mm. long, tipped with a slender yellow style 1 mm. long: stigmas thick, usually 2-lobed: scales black, ovate, obtuse, about 1 mm. long, sparsely pilose, with white hairs of the same length: pedicel about 1 mm. long, twice as long as the nectary: staminate aments unknown.

OREGON: Powder River Mts., in wet meadows near the head of Eagle Creek, *Cusick*, no. 1302, *Piper*, no. 2533: also near the head of Anthony Creek, *Cusick*.

CALIFORNIA : Donner Pass, *Torrey*, no. 489, in 1865. Near Mineral Spring, Sierra Nevada, *Coville* and *Funston*, no. 1427.

These California specimens are imperfect and are somewhat doubtfully referred to the species here described.

Evidently related to the above, but with nearly the foliage of *Salix macrocarpa* Nutt.: it differs from *S. bella* further in having pedunculate pistillate aments, smaller capsules, with the scales short-villous, and no stipules : from *S. pellita* the capsules and scales, as well as the foliage clearly separate it.

A new Species of Globulina

By H. Hasselbring

Among the parasitic fungi collected at Ithaca during the summer of 1898, an interesting plant bearing a remarkable resemblance to the members of the genus *Erysiphe* was found on leaves of *Antennaria plantaginifolia*. The resemblance, however, is restricted to the habit and superficial appearance of the plant. Microscopic examination at once shows it to belong to a widely different group.

The perithecia are brown and membranaceous, and possess a distinct ostiolum. This at once excludes the plant from the *Perisporiales*. The color of the perithecia might at first lead us to place the plant in the *Sphaeriales*, but other, less artificial characters point to the *Hypocreales* as the proper systematic place for the plant in question. As has been said the perithecia are thin and membranaceous, not carbonaceous as in the *Sphaeriales*. The spores are very slender and filiform, and easily break into shorter portions at the septa. This condition is rare among the *Sphaeriales*, but preëminently characteristic of certain groups of the *Hypocreales*. On account of these characters together with the superficial *Erysiphe*-like habitat of the plant its proper position seems to be in the genus *Globulina* Speg., although it differs in certain characters which will be mentioned below.

Up to the present time two species of *Globulina* are known. The first, *G. erysiphoides*, Speg. was described on leaves of Compositae from Brazil. Spegazzini indicates the peculiar habit of the plant by the specific name which he gave it. *G. Ingae* Pat. occurs on leaves of *Inga pachycarpa*, a leguminous plant from Ecuador. The genus *Globulina*, based upon the first species, is described as lacking the ostiolum, but Lindau questions this fact. The perithecia are colored, and paraphyses are said not to be present.

In view of these facts the present species is peculiarly interesting. It is the first northern species of the genus, and like the Brazilian plant occurs on the leaves of a composite. It has the

habit of an *Erysiphe*, the perithecia being superficially seated among the leaf-hairs, with threads of mycelium interwoven among the hairs. The plant differs however, in having brown not brightly colored perithecia with a distinct ostiolum at the apex, and in having paraphyses. With these exceptions, some of which are doubtful on account of the imperfect knowledge of the genus, the plant agrees with the characters of *Globulina* of which it must be considered an undescribed species.

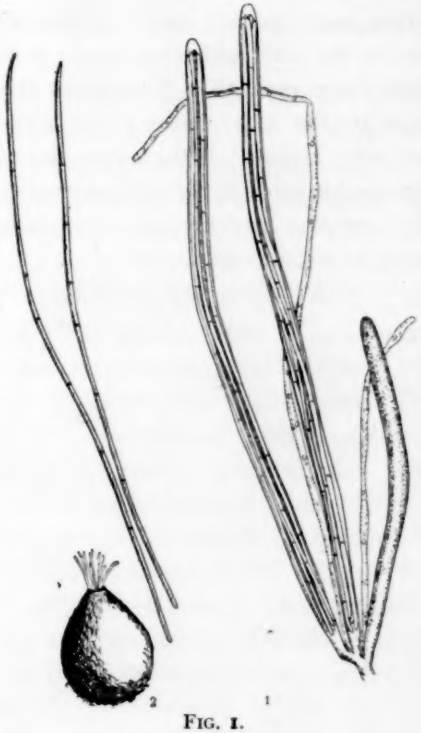

FIG. 1.

Globulina antennariae sp. nov.

Perithecia superficial, scattered, ovate or pyriform, brown membraneous, having a distinct ostiolum: asci cylindrical, slightly narrowed at the ends, mostly somewhat curved, 90–120×4–5 μ; paraphyses flaccid, usually longer than the asci: spores very slender and filiform, septate, hyaline, 90–105 μ long, easily breaking into shorter segments.

A plant having the habit of *Erysiphe*. On leaves of *Antennaria plantaginifolia* Hook. Ithaca, N. Y.

The accompanying cut shows the general appearance of the asci and spores. The asci are born in tufts on the ends of branched fertile hyphae with paraphyses intermixed with them. These tufts often contain many perfect asci together with some immature ones (shown in the cut), and often empty broken shells from which the spores have escaped. Sometimes the upper half or more of an ascus breaks away, leaving the slender spores protruding like long whip lashes. If the cover-glass is tapped gently they may sometimes be made to fall into segments. Fig. 2 of the cut shows the form of a perithecium, with paraphyses exuding under the pressure of a cover-glass.

BOTANICAL DEPARTMENT, CORNELL UNIVERSITY, March 16, 1900.

Proceedings of the Club

Wednesday Evening, March 28, 1900

Vice-President Allen in the chair; about 270 persons were present.

Two resignations were accepted, of Miss Oline M. Ewing and of Mrs. D. P. Kingsford. One new member was elected, Mrs. Isaac Harris, 125 St. Marks Place, Brooklyn, N. Y.

The evening was devoted to a popular lecture on the "Autumn Wild Flowers" native to the vicinity of New York City, by Mr. C. Van Brunt, with lantern-slides, and included not only wild flowers, but also marsh views, autumnal foliage, and tracts of reddened samphire. The speaker took his audience to the Hackensack marshes, showing cat-tail, pickerel-weed, *Sagittaria*, *Coreopsis*, *Miloania*, sneezeweed, the lobelias, etc. Then the marshes about Jamaica Bay were visited, with beach-goldenrod, dodder, *Sabbatia*, *Gerardia*, *Lacinaria*, *Hibiscus*, etc. The weeds surviving about a deserted house yielded some of the most interesting pictures, showing magnified details of burdock, catnip, motherwort, matrimony-vine, knotweeds, etc. Other flowers shown included several goldenrods, asters and gentians, with fruits of milkweeds, holly and *Smilacina*. The series closed with rich displays of color in the herbaceous borders at the Botanical Garden at Bronx Park.

Tuesday Evening, April 10, 1900

President Brown in the chair; twenty persons were present.

Four resignations were reported and accepted, those of Mr. Morris E. Leeds, Dr. Jerome B. Thomas, Jr., Mr. F. Wayland Fellowes, Miss Harriet M. Denison. Two new members were elected, Miss Martha Bunting, 36 E. 12th St., Miss Amy Schüssler, 474 W. 150th St.

On motion of Dr. Underwood, the Club nominated Dr. M. A. Howe as its candidate for the Newberry award for this year.

Dr. Britton called special attention to the Torrey Club excursion next Saturday to the Botanical Garden and the opening of

the Saturday afternoon lecture course on that day. The progress of vegetation there now seems about two weeks late.

Dr. Underwood reported the acceptance by the Editorial Board of a paper on certain Powdery Mildews, being a monograph of the genus *Erysiphe*, by Mr. E. S. Salmon, of the Kew Gardens, London. This will form one of the forthcoming Memoirs of the Torrey Club and its expense has been guaranteed without charge to the Club. A large part of the Memoir is based on American material.

The paper of the evening was by Professor F. E. Lloyd, "Studies in the genus *Lycopodium*." Professor Lloyd discussed the distinguishing characters of the North American species, with reference to structure and habit. Two new species were recognized in this review of the genus. One group of species is remarkable for greater variation here than in Europe, producing five species here and one there; including here *L. inundatum* and its var. *Bigelovii*, *L. adpressum*, *L. alopecuroides* and *L. pinnatum*. The type-specimen of *L. pinnatum* of this group was exhibited. These species develop toward the close of the season a strong, starchy thickening of the growing end of the stem. This serves as a basis of growth the next spring. Professor Lloyd also restored the long-forgotten species *L. Sitchense*, which has 5 rows of leaves, but has been confused with the 4-rowed species, *L. sabinaefolium*.

Dr. Underwood followed, remarking on the general distribution of *Lycopodium*, about 94 species or perhaps properly about 120; of which 12 are North American; perhaps 21 are peculiar to the Andes, and with them grow many others which extend into Mexico or Guiana; about 8 are peculiar to Madagascar, 4 to India, etc.; mostly in mountain regions. *L. cernuum* probably encircles the world in the tropics. The local distribution along Atlantic America is peculiar, *L. alopecuroides*, reported from New England, cannot be traced by accessible specimens north of Long Island. The sprawling and arching habit of this species with spongy interior and caterpillar-like or foxtail-like exterior gives it a very peculiar effect. Dr. Underwood also described his discoveries of *L. porophilum* in Kentucky, Wisconsin, Alabama, etc.

The Secretary raised the question of the distribution of *L. annotinum*, which is present in the Adirondacks, Catskills and

Palisades, and forms compact areas in the Pocono; but has been searched for westward in New York without success.

Dr. Britton spoke of the interest attaching to *L. porophilum* as growing on sandstone rocks. Plants on sandstone rocks which have been attributed to *L. Selago* should be reëxamined with this in mind. Still another form on the sandstones of the Shawangunk also deserves further investigation. Miss Sanial reported collecting five species in or close to New York City.

Dr. Britton referred to a Japanese Witchhazel flowering April 1st at the Botanical Garden, *Hamamelis arborea*, with thorny, pinkish yellow flowers with dark central eye formed by the claret-colored calyx. It has been cultivated at Kew since 1875.

Adjournment followed.

EDWARD S. BURGESS,
Secretary.

WEDNESDAY EVENING, APRIL 25, 1900

Vice-President Allen in the chair; seventeen present.

Two new members were elected: Mrs. William Walter Clark, 27 W. 26th St., New York City; Mr. William L. Fisher, St. Paul's School, Garden City, N. Y.

Dr. Britton suggested that the meeting of the club be held at the home of Dr. Allen, at Litchfield, Conn., during the evening of May 30th; on motion it was determined to do so.

Dr. Britton also proposed that the meeting of May 8th be held in the lecture hall of the Museum Building at the New York Botanical Garden at 4:30 o'clock in the afternoon. On motion the proposition was carried.

The paper of the evening was by Mr. David Griffiths, "Some Saprophytic Fungi." Mr. Griffiths described the mechanical devices employed by the genera of the Pyrenomycetes for the distribution of their spores. The genera discussed were *Podospora*, *Sordaria*, *Deletschia* and *Sporosmia*.

Miscellaneous notes followed. Dr. Underwood exhibited specimens of *Helonias bullata* and *Epigaea repens*, both collected near Metuchen, N. J.

Dr. Britton remarked on the Japanese species of *Pachysandra* then blooming at the New York Botanical Garden, and called at-

tention to the striking similarity between the fragrance of its flowers and those of *Epigaea repens.*

J. K. SMALL, *Secretary, pro tem.*

TUESDAY AFTERNOON, May 5, 1900

The meeting was held in the lecture hall of the Museum Building at the New York Botanical Garden. Dr. Britton presided; twenty-seven persons were present.

The lecture of the afternoon was by Dr. M. A. Howe. The subject was "The Hepaticae." The term Hepaticae was used in a restricted sense, excluding the Anthocerotes. After a few introductory remarks in regard to the position occupied by the Hepaticae in the vegetable kingdom, the speaker reviewed the life-history of a few of the typical forms, the principal details of structure being exhibited by aid of lantern slides. The slides also showed the habit characters of various local species and of some from the Pacific coast.

J. K. SMALL, *Secretary pro tem.*

WEDNESDAY EVENING, MAY 30, 1900

The meeting was held at Hazelwood, the residence of Vice-President Dr. T. F. Allen, near Litchfield, Conn., subsequent to a field excursion arranged by Dr. Allen, in the vicinity of Litchfield, the Club being his guests from May 29th to May 31st.

Dr. Allen in the chair and sixteen members present.

In the absence of the Secretary, Dr. N. L. Britton was elected Secretary *pro tem.*

The minutes of the meeting of May 8, 1900, were read and approved.

Messrs. F. L. Montgomery and E. A. Colby, duly recommended by the Committee on Admissions were elected active members of the Club.

The resignations of Mrs. Charles M. Kirby, Dr. Leon Labonde and Miss Mathilde E. Sutro were presented and accepted.

It was resolved that the regular meetings of the second Tuesdays in October and November be held at the Museum Building of the New York Botanical Garden at four o'clock P. M.

Professor Lloyd called attention to the occurrence of nec-

taries * on the leaves of *Pteridium aquilinum*. The glands are found on the rachis, one below the insertion of each pinna, and may be recognized as modified oval areas covered by a dark red epidermis. The color is due to the presence of matter dissolved in the sap, and is found also in lines running up and sometimes down the rachis from the glands. These are very active during the rapid growth of the frond, their activity ceasing on the attainment of maturity. The secretion, which is very abundant, is formed independently of bleeding pressure, and the fluid is thick and syrupy. So rapidly does it accumulate that one may notice the increase in the size of the drops with a hand lens. The secretion escapes through modified stomata similar in form to the water-stomata of *Tropaeolum*. The glandular tissue beneath extends deeply into the cortical mass of the petiole ; its cells are small and contain chlorophyll.

Small ants, and one honey-gathering dipterous insect were noticed visiting the glands ; none were seen to be gnawed by the insects. As Francis Darwin observed, the plant has few natural enemies or none, and the interpretation must be sought in the internal economy of the plant, probably in connection with nutrition. The abundant excretion of sugar may be a carrier of or an accompaniment to the excretion of some harmful substance. It is noteworthy that up to the present time no other pteridophyte has been reported to be possessed of nectar-secreting organs. The plants on which the observations were made grew near Bantam Lake, Litchfield, Conn.

Dr. Britton remarked on a young tree of the Swamp Spruce, *Picea brevifolia* Peck, found during the day in a sphagnum bog near Litchfield, and stated that this was probably the most southern known station for this species in New England. The short glaucous leaves and nearly glabrous twigs readily distinguish this tree from the Black Spruce, *P. Mariana*.

Mrs. Britton exhibited specimens of the red-flowered Columbine of the Litchfield region, and remarked on its growth in open fields and the pubescent character of the plant, differing in these features from the plant of the vicinity of New York, which inhabits

* Described briefly by Francis Darwin ('77), and later by Figdor ('91).

rocky ledges and is nearly or quite glabrous. She noted that the pubescent plant is also abundant in fields on the Pocono plateau of Pennsylvania.

A vote of thanks was tendered to Dr. Allen for his most generous and agreeable hospitality.

N. L. BRITTON,
Secretary pro tem.

Congdon, J. W. New species, principally from Mariposa County, California. Erythea, **7**: 183–189. 20 Je. 1900.

New species in *Sidalcea*, *Ribes*, *Epilobium*, *Echinocystis*, *Selinum*, *Erigeron*, *Wyethia*, *Cnicus*, *Gilia*, *Collinsia*, *Mimulus*, *Castilleia* and *Orthocarpus*.

Copeland, E. B. I. Soja bean for inhibition experiments. II. Diffusion through the Cuticle. Bot. Gaz. **29**: 347–352. 25 M. 1900.

Davis, B. M. The Fertilization of *Albugo candida*. Bot. Gaz. **29**: 297–311. *pl. 1*. 25 M. 1900.

Fernald, M. L. *Scirpus sylvaticus*: a correction. Rhodora, **2**: 106. My. 1900.

H[ooker,] J. D. *Berlandiera tomentosa*. Curt. Bot. Mag. III., **55**: *pl. 7680*. 1 O. 1899.

Native of the southern United States.

H[ooker,] J. D. *Calathea picta*. Curt. Bot. Mag. III., **55**: *pl. 7674*. 1 S. 1899.

Native of Brazil, n. sp.?

H[ooker,] J. D. *Carludovica Lancheana*. Curt. Bot. Mag. III., **55**: *pl. 7683*. 1 N. 1899.

Native of New Grenada.

H[ooker,] J. D. *Cereus viridiflorus*. Curt. Bot. Mag. III., **55**: *pl. 7688*. 1 D. 1899.

Native of New Mexico and Colorado.

H[ooker,] J. D. *Cyphomandra betacea*. Curt. Bot. May. III., **55**: *pl. 7682*. 1 N. 1899.

New Grenada and Peru.

H[ooker], J. D. *Epipactis gigantea*. Curt. Bot. Mag. III., **55**: *pl. 7690*. 1 D. 1899.

Native of Western N. America and Temperate Asia.

H[ooker], J. D. *Hidalgoa Wercklei*. Curt. Bot. Mag. III., **55**: *pl. 7684*. 1 N. 1899.

Native of Costa Rica.

H[ooker], J. D. *Mina lobata*. Curt. Bot. Mag. III., **55**: *pl. 7689*. 1 D. 1899.

Native of Mexico.

H[ooker], J. D. *Odontoglossum brevifolium*. Curt. Bot. Mag. III., **55**: *pl. 7687*. 1 D. 1899.

Hollick, A. A Report on a collection of Fossil Plants from northwestern Louisiana. Geol. Surv. La. Rept. **1899**: 276–288. *pl. 32–48.*

New species in *Quercus*, *Artocarpus*, *Ficus*, *Toxylon*, *Cryptocarya*, *Celastrus*, *Andromeda* and *Apocynophyllum*.

Hume, H. H. A new species of *Puccinia*. Bot. Gaz. **29**: 352–353. 25 M. 1900.

Jenman, [G. S.]. *Asplenium Fawcettii* n. sp. Gard. Chron. III., **26**: 121. 12 Au. 1899.

From Jamaica.

Knowlton, F. H. Fossil Plants Associated with the Lavas of the Cascade Range. Ann. Rept. U. S. Geol. Surv., 1898–99, 203, 37–64. *pl. 1–6.* 1900.

New species in *Acrostichum*, *Pinus*, *Juglans*, *Quercus* (4), *Ulmus*, *Ficus* (2), *Benzoin*, *Cinnamomum*, *Laurus* and *Phyllites* (2).

Kurtz, F. Sobre la existencia de una Dakota-Flora en la Patagonia Austro-Occidental. Revista del Museo de la Plata, **10**: 1–18. 1899.

New species in *Araucarites*, *Abietites* and *Perseophyllum*.

Nelson, A. Correction in *Aragallus*. Erythea, **7**: 189, 190. 20 Je. 1900.

Robinson, B. L. *Sebastiana* (?) *bilocularis* Wats. Erythea, **7**: 189. 20 Je. 1900.

Rowlee, W. A., &Nichols, S. P. The Taxonomic value of the staminate Flowers of some of the Oaks. Bot. Gaz. **29**: 353–356. 25 M. 1900. [Illust.]

Smith, R. W. The Structure and Development of the Sporophylls and Sporangi of *Isoetes*. Bot. Gaz. **29**: 312. *pl. 1.* 25 M. 1900.

White, D. Fossil Flora of the Lower Coal Measures of Missouri. Monogr. U. S. Geol. Surv. **37**: I–XI; 1–467. *pl. 1–73.* 1899.

New genus *Brittsia*, and new species in *Eremopteris*, *Mariopteris*, *Sphenopteris* (8), *Oligocarpia*, *Alethopteris* (2), *Pecopteris* (2), *Aphlebia*, *Linopteris*, *Cyclocladia*, *Sphenophyllum*, *Lepidodendron*, *Lepidophloios*, *Lepidophyllum* (2) and *Taeniophyllum*.

Ward, F. Description of a new genus and twenty new species of fossil cycadean trunks from the Jurassic of Wyoming. Proc. Wash. Acad. Sci. **1**: 253–300. *pl. 14–21.* F. 1900.

New genus *Cycadella* and 20 new species.

Ward, F. With the collaboration of Walter P. Jenney, Wm. M. Fontaine and F. H. Knowlton. The cretaceous Formation of the Black Hills as indicated by the fossil plants. Ann. Rept. U. S. Geol. Surv. 1897–98, **192**: 521–946. *pl. 57–172.* 1899.

Webster, H. [Note on] *Peziza rapulum* Bull. Rhodora, **2**: 106. My. 1900.